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Air Proving Ground Command

*Final
Report*

TEST CONDUCTED
..... AT
EGLIN A.F.B. FLORIDA

PROJECT NO. AP6/ADA/43-A-1

SUBJECT: OPERATIONAL SUITABILITY TEST OF THE
T-160 20MM GUN INSTALLATION IN F-86F-2 AIRCRAFT

DATE 29 APRIL 1954

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HEADQUARTERS
AIR PROVING GROUND COMMAND
Eglin Air Force Base, Florida

29 April 1954

PROJECT NUMBER APG/ADA/43-A-1

OPERATIONAL SUITABILITY TEST OF THE T-160 20MM GUN INSTALLATION IN F-86F-2 AIRCRAFT

1. Transmitted herewith is the final report on Project Number APG/ADA/43-A-1, which was conducted to determine the operational accuracy and reliability of the T-160 (20mm)/F-86F-2 gun/aircraft installation. The information contained in this report supplements that obtained during the combat testing of this system and reported on Project No. APG/ADA/43-F-1.
2. This report and the report covering the combat evaluation of the 20mm T-160/F-86F-2 system are parts of the APGC's contribution to the inter-command Project "Gun Val." At the beginning of project "Gun Val," an initial study was made of a proposed list of armament installations. This study was prepared jointly by AMC, APGC, WADC, and AFAC as the "Interim Gun Val Study," and published 15 April 1952. The testing of the last two years has been conducted to substantiate or refute, with actually observed data, the results of this study.
3. The T-160 gun is programmed to replace the .50 M-3 for use in future day fighter aircraft which will be employed during visual conditions against enemy aircraft and ground targets.
4. Since the 20mm T-160 gun is programmed to replace the caliber .50 M-3 gun, a direct comparison must be made of these weapons. Testing to date indicates that the accuracy of the M-3 is greater at the shorter ranges, (under 600 yards), where historically most of the effective shooting has been done. Expected operational accuracy of the 20mm is greater at the long ranges, (over 600 yards). There are, however, several comparatively minor installation deficiencies which require correction. Also, the compressor stall encountered in Project Number APG/ADA/43-F-1 remains uncorrected.

CONFIDENTIAL

54


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5. In deciding whether the T-160 gun installation can either supplement or replace the caliber .50 M-3 gun installation, the comparative overall capability to inflict damage on targets under combat conditions must be considered. The results of tests to date strongly indicate that the T-160 installation does not provide a desired degree of improvement over the M-3. However, in view of the better accuracy at longer ranges and the higher speeds of future aircraft, it is considered that an equal overall performance or relatively small improvement in the present installation is acceptable.

6. At present, available fire control systems impose a limiting factor on the use of the gun installation. Within the capability of the available and programmed fire control systems, the caliber .50 installation will achieve essentially the same results as the T-160 installation.

7. In view of the above, it appears that the decision as to whether the T-160 or the M-3 should be installed in any particular model aircraft must consider the factors of availability, the logistics and training problems imposed by the introduction of a new gun system, and the cost and time involved in retro-fitting and/or re-design of aircraft presently designed for the T-160 installation. The efforts of the USAF should continue to be directed toward the acquisition of a system that will result in substantial improvement over the existing caliber .50 installation.

8. Both the installation deficiencies and the compressor stall problem must be resolved before the T-160 is acceptable for the F-86H or similar aircraft.


PATRICK W. TIMBERLAKE
Major General, USAF
Commander

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**HEADQUARTERS
AIR FORCE OPERATIONAL TEST CENTER
Eglin Air Force Base, Florida**

FINAL REPORT

ON

**OPERATIONAL SUITABILITY TEST OF THE T-160 20 MM GUN
INSTALLATION IN F-86F-2 AIRCRAFT,
PROJECT NO. APG/ADA/43-A-1**

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TABLE OF CONTENTS

	<u>PAGE</u>
1. INTRODUCTION	5
2. OBJECT	5
3. OPERATIONAL ASPECTS	6
a. Accuracy	6
(1) Harmonization	6
(2) Air-to-Air Firing	6
(3) Air-to-Ground Firing	6
b. Reliability	7
(1) Armament	7
(2) Fire Control System	7
(3) Aircraft	7
c. Organizational Impact	7
4. CONCLUSIONS	7
5. RECOMMENDATIONS	8
APPENDICES:	
APPENDIX A Photograph of Gun/Aircraft Installation	9
APPENDIX B F-86F (T-160 Guns) Boresighting and Harmonization Procedure	11
APPENDIX C Tabulation of Air-to-Air and Air-to-Ground Firing	15
APPENDIX D Functional Deficiencies	20
APPENDIX E Photographs of Damage to Aircraft	25

1. INTRODUCTION:

a. Project "Gun-Val" (APG/ADA/43-A) was established to test a series of different foreign and domestic aircraft weapons installed in various types of aircraft to determine the most effective weapons for service use. The following supplemental report pertains only to accuracy and reliability evaluation of the T-160 20 mm installation in a F-86F-2 type aircraft. Photographs of the gun/aircraft installation are included as Appendix A.

b. This report is a continuation of previous tests on this configuration. Extensive combat tests were conducted in Korea under Project No. APG/ADA/43-F-1. Also, preliminary shake-down testing, prior to combat tests, was conducted under Project No. APG/ADA/43-A-1.

c. The four (4) gun T-160 20 mm installation, with its related ammunition, was designed for the purpose of providing the Air Force with a more effective armament system than the present six (6) gun caliber .50 installation.

d. The T-160 20 mm gun is a gas operated, belt fed, electrically fired, automatic weapon. Its design characteristics are as follows:

(1) Rate of fire	1500 RPM
(2) Muzzle velocity	3150 FPS
(3) Operation	Gas revolver type
(4) Weight of gun (gun and feeder)	162 pounds
(5) Length of gun	72 inches
(6) Width of gun	8.58 inches
(7) Height of gun	8 inches
(8) Length of barrel	53.56 inches
(9) Recoil force	6,000 pounds
(10) Type of feed	Link

2. OBJECT:

a. To determine overall accuracy of the gun/aircraft installation for use in air-to-air and air-to-ground firing.

b. To investigate gun/aircraft installation reliability, including field maintenance and support requirements.

3. OPERATIONAL ASPECTS:

a. Accuracy:

(1) Harmonization:

The test aircraft was harmonized and fired-in at 1300 foot range using practice ammunition. The selection of this range offered an average distance for the three (3) firing ranges, 1200, 1800 and 2400 feet. Dispersion patterns were slightly larger than those obtained during the preliminary shake-down firing tests conducted in October 1952 at Edwards AFB, California (reference Preliminary Report APG/ADA/43-A-1). This increase in dispersion was attributed to excessive wear in the armament installation. As previously reported in the final report on the combat suitability test of this installation, time required to obtain acceptable dispersion patterns remains excessive (20-30 manhours). (Reference Final Report APG/ADA/43-F-1.) Accumulated experience of personnel participating in two previous tests on this installation failed to reduce the time required for harmonization and fire-in. Harmonization and fire-in procedures and dispersion patterns are listed in Appendix B.

(2) Air-to-Air Firing:

Forty-five air-to-air sorties, utilizing radar ranging were accomplished during the accuracy phase. Standard 6' x 30' banner targets with X-band reflectors were used. A comparison of the accuracy of the four gun T-160 20 mm and six gun M-3 caliber .50 (reference APG/ADA/18-A-1) installations based on the average of four best sorties for each firing range is as follows:

	Firing Range		
	1200'	1800'	2400'
T-160, 20mm 4 gun (per cent hits)	20.5%	19.3%	18%
M-3, .50 Cal. 6 gun (per cent hits)	27.8%	22 %	10%

(3) Air-to-Ground Firing:

Twenty-four (24) air-to-ground sorties were flown against 12' x 12' panel targets mounted approximately

30° from the verticle. Air-to-ground accuracy comparison of the T-160 4 gun 20 mm and the 6 gun .50 caliber (reference APG/TAT/90-A-3) installation based on the average of ten (10) best sorties is as follows:

T-160 20 mm 4 gun	45.5%
M-3 Caliber .50 6 gun	37%

Complete tabulation of air-to-air and air-to-ground firing records is included as Appendix C.

b. Reliability:

(1) Armament:

The reliability achieved during this test was comparable to that obtained during previous testing of the installation. A total of 42,865 rounds of 20 mm ammunition were loaded with 38,032 rounds fired for a total fire-out of 88.6%. Eighty-one (81) stoppages occurred during the test resulting in a stoppage rate of 2.13 per 1000 rounds fired. A complete breakdown of the stoppages encountered is listed in Appendix D.

(2) Fire Control System:

There were no adverse effects on the fire control system noted during firing with this installation.

(3) Aircraft:

On six occasions, the aircraft suffered minor damage in the air intake fuselage assembly area. Photographs illustrating damage to the aircraft are listed in Appendix E.

c. Organizational Impact:

No additional requirements were determined for personnel, facilities or equipment, other than those discussed in Project No. APG/ADA/43-F-1. The requirement that armorers be given additional instruction in electrical troubleshooting, noted during the combat test was emphasized particularly during this supplementary test. (See Appendix D, Personnel.)

4. CONCLUSIONS:

a. The accuracy of this four gun 20 mm installation in the

F-86F-2 is comparable to that obtainable with a six gun .50 caliber installation.

b. Reliability of the T-160 gun at the stage of development represented by this installation is acceptable. However, present functional deficiencies must be corrected in production installations before reliability will be satisfactory for operational use.


c. The time required for harmonization, boresighting and fire-in in this installation is unacceptable.

5. RECOMMENDATIONS:

a. Correct the functional deficiencies noted in Appendix D.

b. Provide, in future installations utilizing this weapon, adequate facilities for harmonization, boresighting and fire-in.

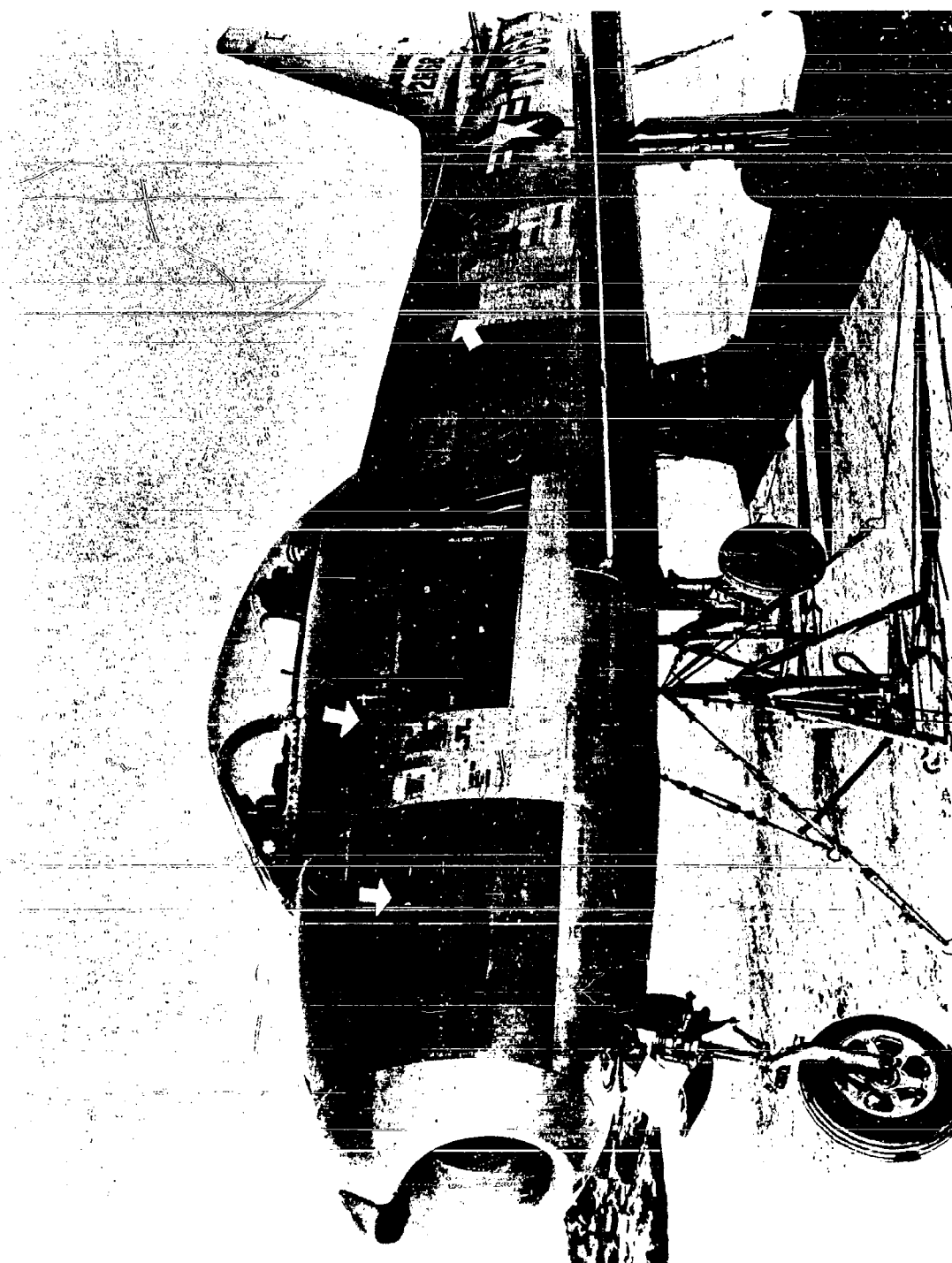
c. Furnish armorers with additional instruction in electrical trouble-shooting procedures.


W. B. PUTNAM
Colonel, USAF
Commander

APPENDIX A

PHOTOGRAPH OF GUN/AIRCRAFT

INSTALLATION



APPENDIX B

F-86F (T-160 GUNS) BORESIGHTING & HARMONIZATION PROCEDURE

1. The procedure used for harmonizing eight F-86F "Gun-Val" aircraft at Edwards Air Force Base, California, is as follows:

a. A 12' x 12' master target (see diagram #1) is placed 1800 feet from the airplane. A sturdy frame must be built so that succeeding targets may be erected in the same position as the master target.

b. The aircraft is placed in a 3° nose up attitude and levelled laterally by use of a gunner's quadrant placed on the levelling lugs of the aircraft. Wing and nose jacks must be used for this step.

c. Install aligning sights on aircraft and position the master target horizontally and vertically until the aligning sights on the aircraft are aligned with point "A" on master target.

d. Level computer and adjust the electrical cage sight reticle on point "C" of master target.

e. If an accurate muzzle boresight tool is available, adjust guns so that they converge on point "C", otherwise eliminate this step. (Guns are factory boresighted for parallel harmonization on a 1000 inch range and can be assumed to be approximately level when the aircraft is in this position.)

f. Elevate nose of aircraft until aligning sights on aircraft are superimposed on reference point "B" of master target. This step is to compensate for bullet drop (76.56").

g. Tie aircraft down using steel cables with turnbuckles on nose, wing and tail positions. After tie down is accomplished, check to see if aligning sights on aircraft are still aligned with point "B".

h. Remove master target and install a 12' x 12' panel target so that its center is placed in the same position as point "C" on master target. Draw a two (2) mil circle (3.6" diameter) around the center of the target.

i. Unlatch gun gas seals and remove muzzle stabilizers from around gun barrels. Fire single rounds from individual guns, adjusting each gun until hits are scored in the two (2) mil circle of the target; adjust gas seal brackets so that the gun barrels do not touch the gas seals when they are latched. Adjust muzzle stabilizer brackets so that no gun barrel movement is noted when the muzzle stabilizers are locked

MASTER FIRE IN TARGET
1800' RANGE POINT HARMONIZATION
F-86 A/C WITH T-160 20MM GUNS

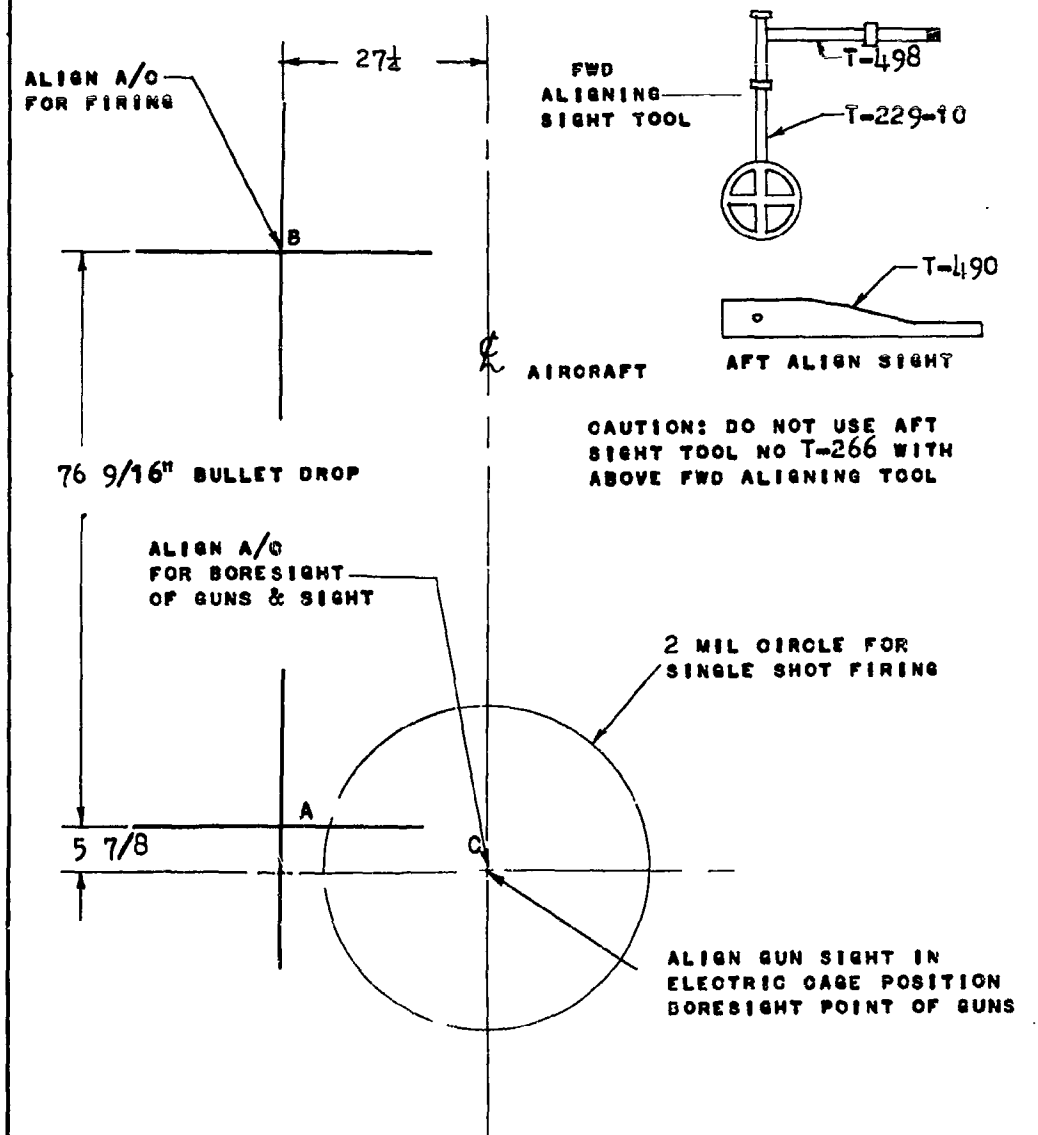


Diagram #1
Appendix B - Page 2
12

in place. Fire a minimum of three rounds from each gun with gas seals and muzzle stabilizers in place to assure that the gun barrels were not moved during the process of adjusting the muzzle stabilizer in place.

j. Using a different color ammunition in each gun, fire a ten round burst from each gun simultaneously on a clean 12" x 12" target with a 4.5 mil dispersion circle (8.1") drawn around its center. If less than 66-2/3% of the rounds fired strike in the 4.5 mil dispersion circle, the gun or guns of which patterns fall outside the circle should be readjusted and ten round bursts repeated until 66-2/3% hits are scored within the 4.5 mil circle.

2. In the event an 1800 foot fire-in range is not available, the same procedure above may be used for firing in on a 1000 foot range by use of a master target drawn in accordance with diagram #2 with the following exception:

a. Instead of drawing a two (2) mil circle around the center of the target as listed in paragraph 1 h, above, draw a two (2) mil concentric circle for each gun around a point which allows for a "Gun Tow In" of five-ninths the distance of the mean gun line. Reference diagram #2. Note that point "C" in this diagram is not in the same position as point "C" in diagram #1; consequently if a boresight tool is used to align the guns as described in paragraph 1 e, each gun must be sighted on the center of its respective two (2) mil circle.

3. The boresighting and harmonization procedure outlined above was derived to provide increased hit and kill probability on actual combat targets. It must be realized, however, that reduced size of the impact pattern will make small tracking errors critical.

MASTER FIRE IN TARGET - 1000' RANGE
 FOR GUNS & SIGHT CONVERGENCE AT 1800'
 F-86F A/C WITH T-160 20MM GUNS

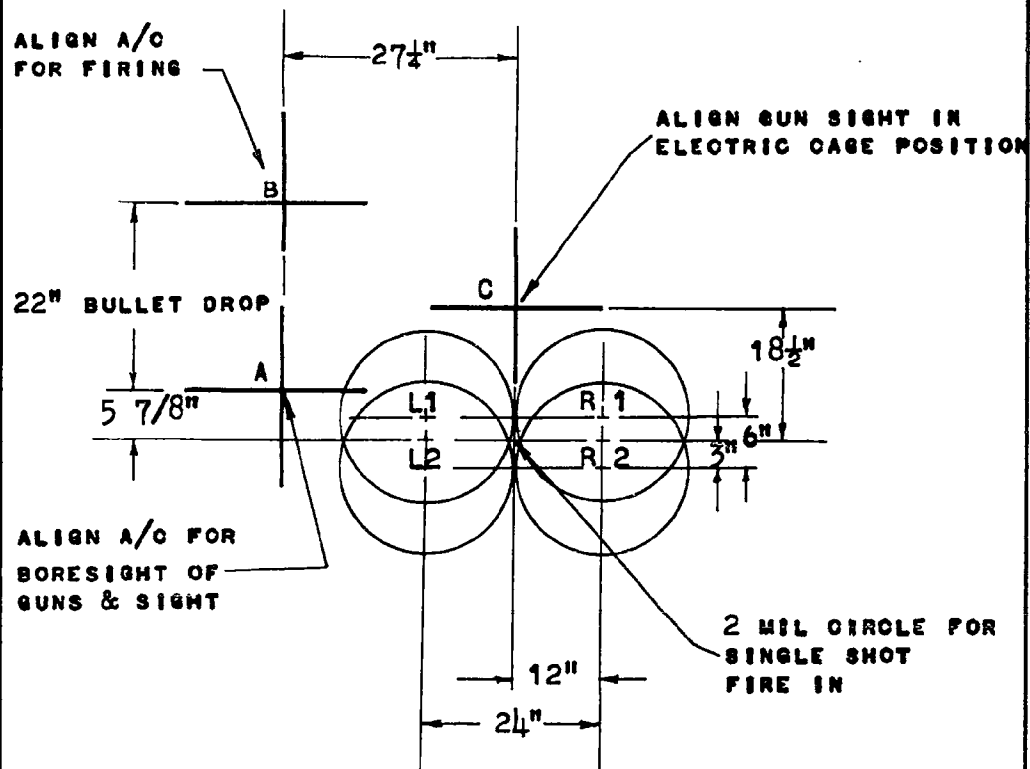


Diagram #2
 Appendix B - Page 4
 14

APPENDIX C

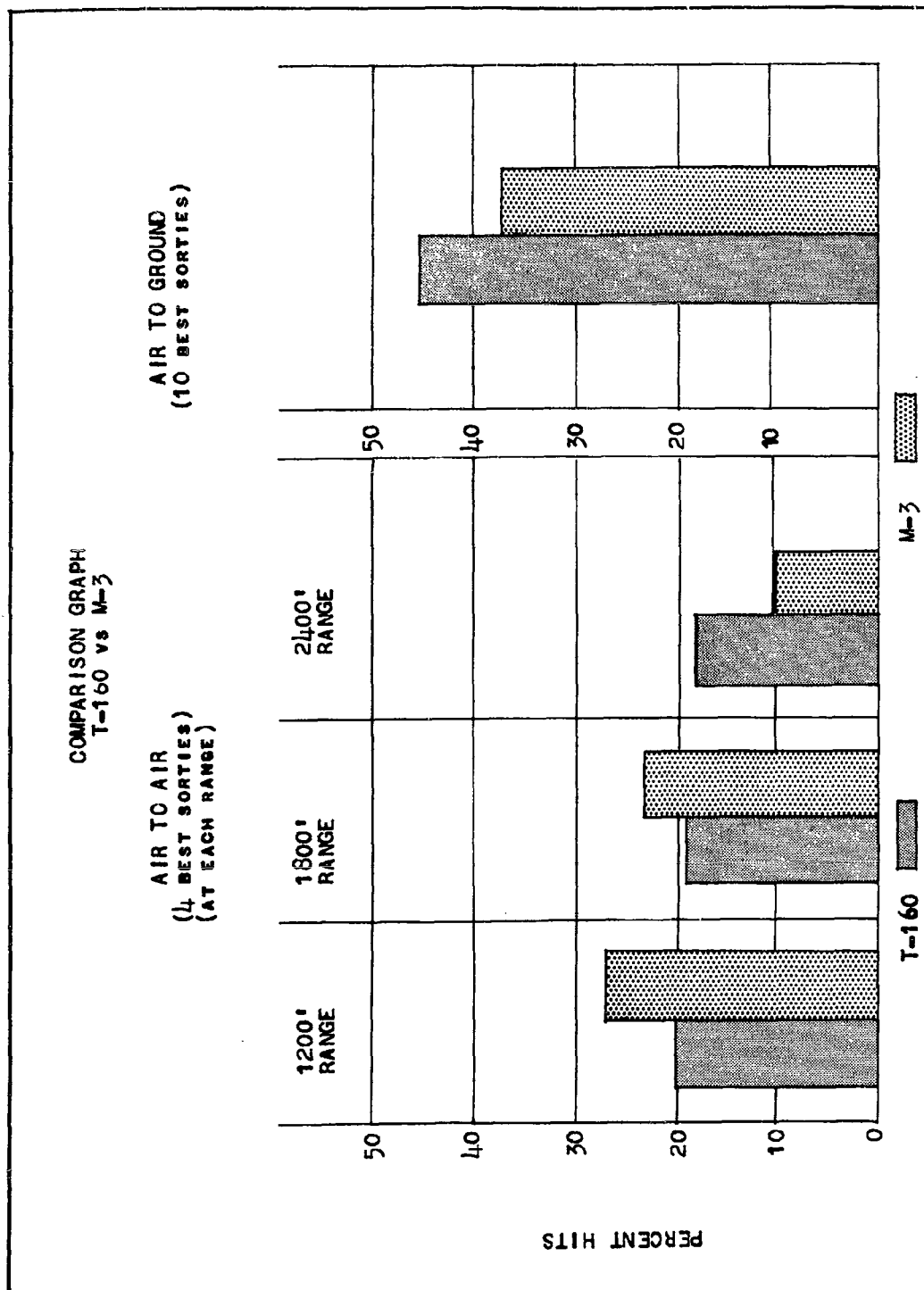
COMPLETE TABULATION OF AIR-TO-AIR FIRING

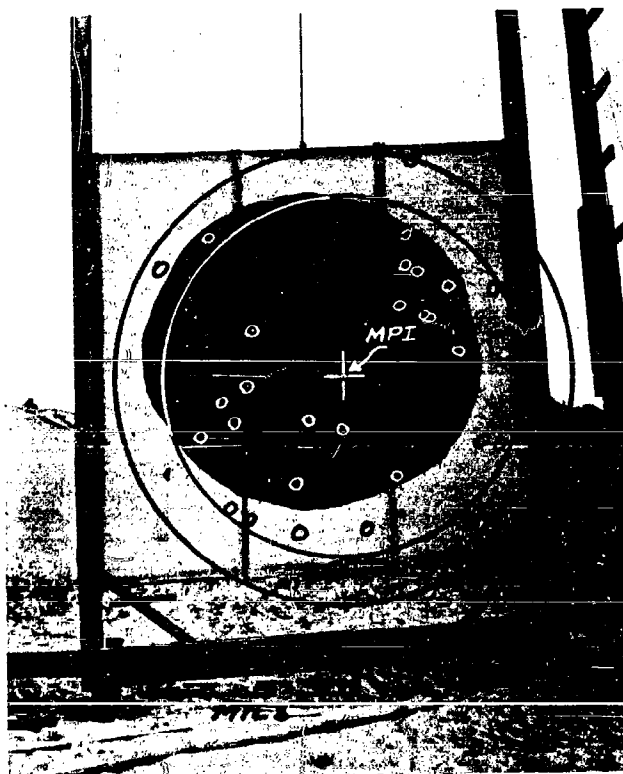
PILOT	1200'		1800'		2400'		1200'	
	RDS FIRED	HITS %	RDS FIRED	HITS %	RDS FIRED	HITS %	RDS FIRED	HITS %
E	460	21 4.6	319	14 4.4	460	33 7.2	352	25 7.1
	460	0 0	460	39 9.0	460	111 24.0	34.7	72 20.7
	421	59 14.0	460	69 15.0	460	59 12.6	345	49 14.2
F	408	3 0.7	460	28 6.0	460	73 16.0	400	65 16.3
	308	37 12.0	349	49 14.0	456	36 8.0	398	91 22.8
	380	33 8.7	345	57 15.0	460	89 19.4	460	80 17.7
G	440	15 3.4	460	70 15.0	316	23 7.2	460	51 11.1
	353	22 6.3	378	45 12.0	460	29 6.3	428	91 21.2
	230	20 8.7	460	125 27.2	359	13 3.6	412	42 10.2
B	380	36 9.5	460	70 15.0	460	32 6.9		
	386	44 11.4	460	81 17.6	460	39 8.4		
	345	38 11.0	316	49 15.5	440	44 10.0		

APPENDIX C

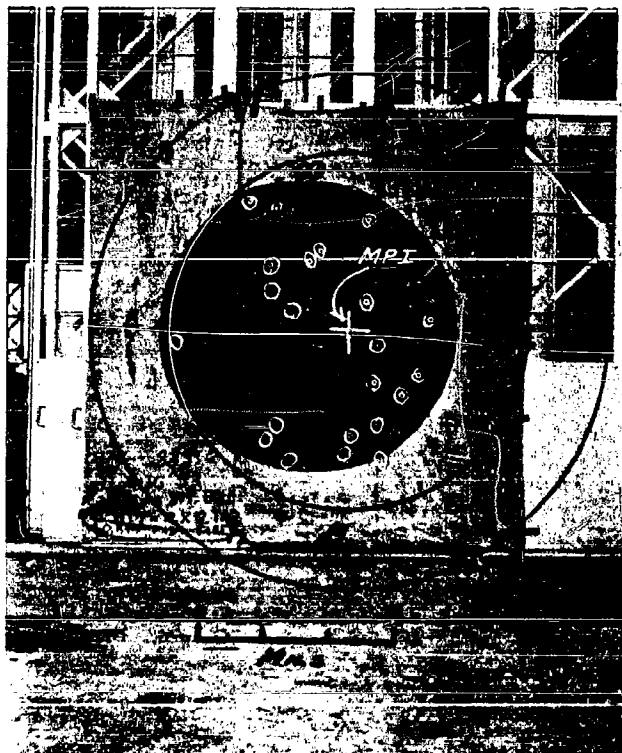
COMPLETE TABULATION OF AIR-TO-GROUND FIRING

PILOT	1200'			2400'		
	ROUNDS FIRED	HITS	% HIT	ROUNDS FIRED	HITS	% HIT
B	460	46	10	460	139	30.2
	385	70	18.0	460	78	16.9
	460	181	39.3	407	49	10.8
E	460	101	21.9	349	70	20.0
	352	100	28.4	460	57	12.8
	398	88	22.4	362	120	33.2
F	460	171	37.1	345	248	71.9
	400	150	37.5	460	103	22.4
	460	220	43.0	460	74	16.1
G	389	197	50.6	460	181	39.3
	460	50	10.8	460	11	2.3
	370	244	66.0	402	77	19.1





PHOTOGRAPHS OF BORESIGHT PATTERNS



PHOTOGRAPHS OF BORESIGHT PATTERNS

Appendix C - Page 5

APPENDIX D

FUNCTIONAL DEFICIENCIES

Armament Reliability and Maintenance

1. INTRODUCTION:

This report covers the period of 8 June 1953 through 21 October 1953 and includes all firing conducted at Eglin AFB, Florida during this period. The following is the reliability breakdown of the installation:

TOTALS:

Rounds Loaded	42,365
Rounds Fired	38,082
Fire Out Percent	88.6%
Number of Stoppages	81
Stoppage Rate/1000 Rounds	2.13
Number Missions where Stoppages Occurred	51
Missions Flown	92

STOPPAGE CAUSES ATTRIBUTED TO:

Guns	40
Installation	15
Personnel	4
Ammunition	2
Links	2
Undetermined	18

2. ARMAMENT RELIABILITY:

a. Gun:

- (1) Of the total of 81 stoppages occurring during the test, 40 were caused by "gun" malfunctions. These stoppages

were 49.4% of the total stoppages. The malfunctions which were attributed to the gun were as follows:

- (a) Broken or shorted harness assembly - 16
- (b) Shorted firing pin assembly - 3
- (c) Shorted or broken knife blade assembly - 6
- (d) Broken or binding switch tongue - 3
- (e) Broken ADF spring - 1
- (f) Round retainer failure - 1
- (g) Open circuit at ADF contacts - 2
- (h) Eroded barrel causing failure to extract - 1
- (i) Firing pin set back in insulation - 3
- (j) Broken recoil spring nut - 1
- (k) Popped rivets in feeder link guide pan - 1
- (l) Broken barrel lock - 2

- (2) The first malfunction, broken or shorted harness assembly, accounted for 40% of the total gun stoppages. Based on the above, the harness assembly was the most unreliable component of the gun.

b. Installation:

- (1) Of the 81 stoppages occurring, 15 were attributed to the installation. These stoppages accounted for 18.5% of the total stoppages. The malfunctions pertaining to the installations were:

- (a) Link chutes - 4
- (b) Purge system, electrical and linkage - 4
- (c) Failure of lower link deflector causing link jam - 5
- (d) Broken cannon plug - 2

- (2) Based on this data, the link chutes, purge system and lower link deflector are the most unreliable items in the installation. These three components accounted for 86.9% of the installation malfunctions.

c. Personnel:

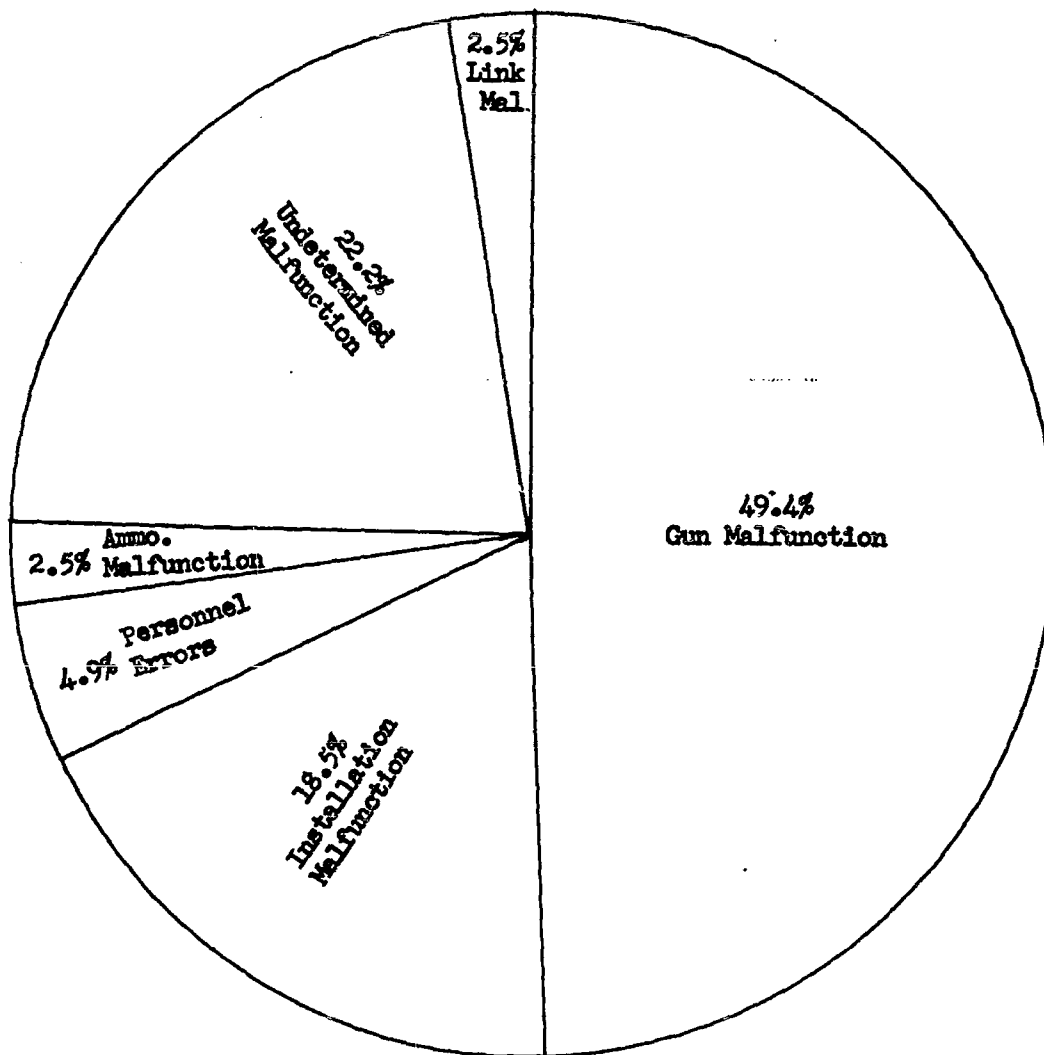
- (1) Personnel errors resulting in gun stoppages totaled 4 out of the total 81 stoppages. These errors amounted to 4.9% of the total stoppages. Errors by personnel were:
- (a) Improper inspections - 2
 - (b) Improper gun repair - 1
 - (c) Improper assembly of the gun - 1
- (2) All of these personnel errors can be attributed to improper supervision of inexperienced personnel who were engaged in on-the-job training.
- (3) Although experienced personnel were used for trouble-shooting gun stoppages, electrical malfunction could not be detected. This is reflected in the 22.2% undetermined stoppages.

d. Ammunition:

- (1) Of the 81 total stoppages 2 were caused by ammunition malfunctions. These 2 account for 2.5% of the total stoppages. The malfunctions occurring were:
- (a) Defective primer - 1
 - (b) Blown primer - 1

e. Links:

- (1) Two (2) malfunctions were attributed to links of the 81 total stoppages. The two (2) stoppages account for 2.5% of the total stoppages. The malfunctions which caused stoppages were:
- (a) Link ring disengaged causing belt separation - 2



f. Undetermined or Unknown:

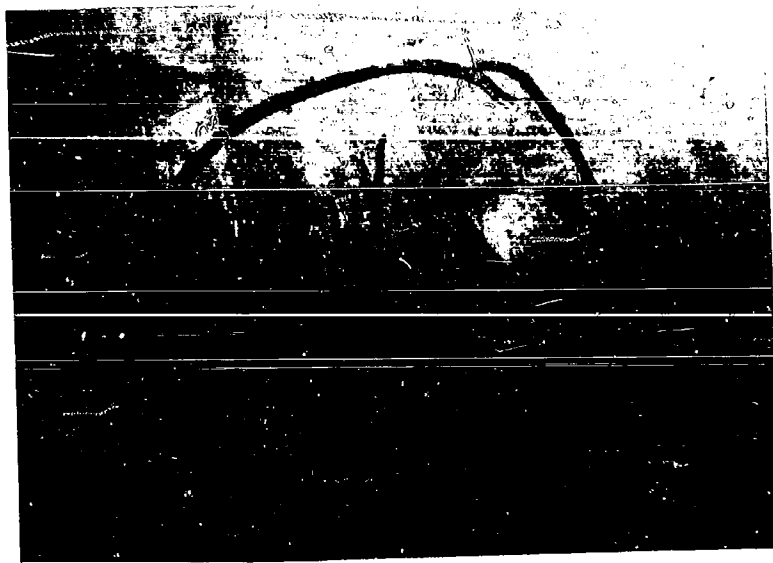
- (1) Of a total of 81 stoppages 18 were classed as unknown causes. These 18 stoppages account for 22.2% of the total. Malfunctions encountered were:

(a) Link jam in feeder	- 5
(b) Failure to fire	- 5
(c) Broken link ring	- 3
(d) Failure to extract	- 2
(e) Separated belt	- 2
(f) De-linked round	- 1

- (2) Of these 18 unknown malfunctions link pins and failure to fire accounted for 55.5% of the total unknown malfunctions.

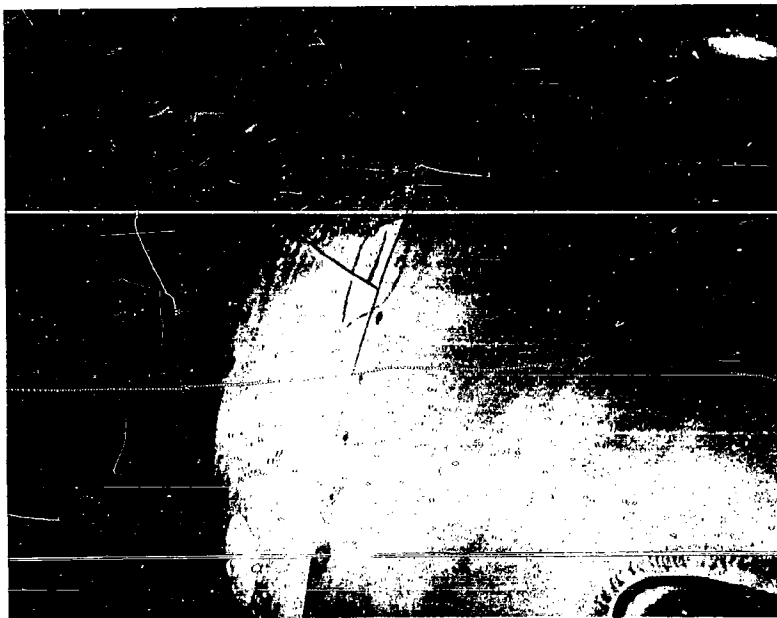
3. RECOMMENDATIONS:

The electrical system for the T-160 gun be redesigned to afford acceptable reliability.



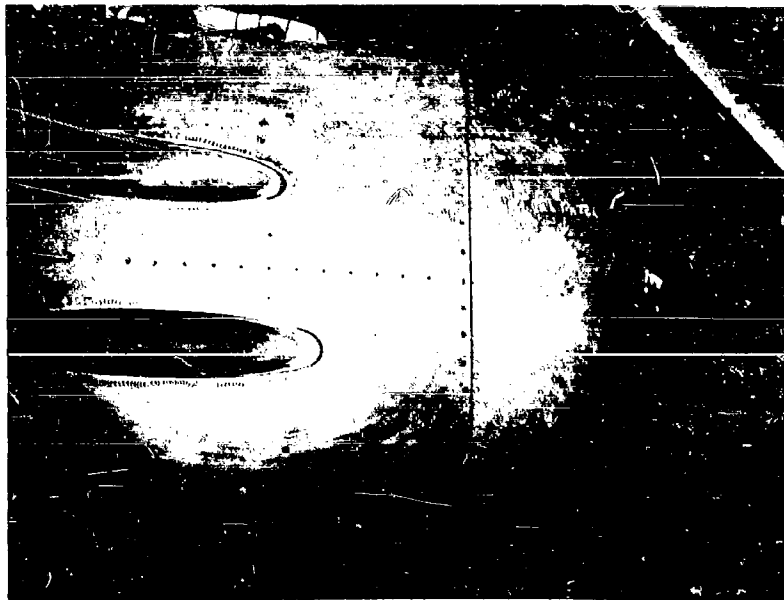
PHOTOGRAPHS OF DAMAGE TO AIRCRAFT

Appendix E - Page 1
25



PHOTOGRAPHS OF DAMAGE TO AIRCRAFT

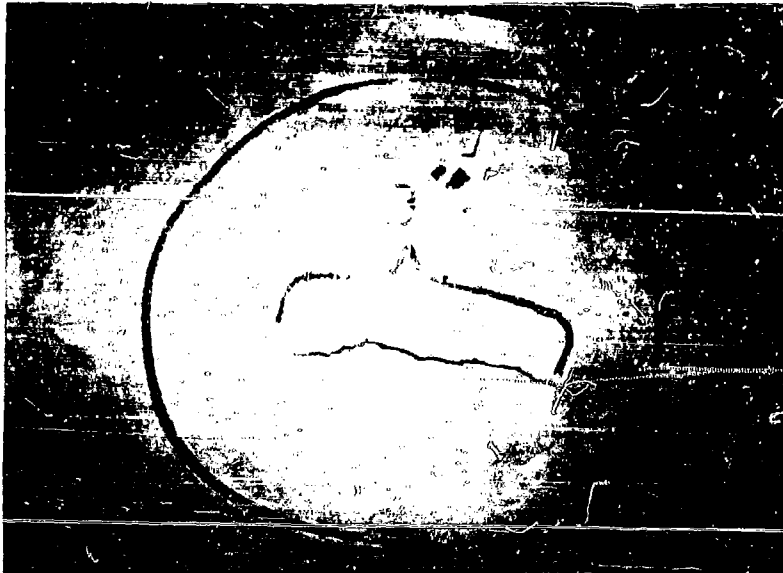
Appendix E - Page 2
26



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Appendix E - Page 3

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Appendix E - Page 4

28

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Wright-Patterson AFB OH 45433-5714

SUBJECT: Technical Reports Cleared for Public Release

References: (a) HQ AFMC/PAX Memo, 26 Nov 01, Security and Policy Review,
AFMC 01-242 (Atch 1)

→ (b) HQ AFMC/PAX Memo, 19 Dec 01, Security and Policy Review,
AFMC 01-275 (Atch 2)

(c) HQ AFMC/PAX Memo, 17 Jan 02, Security and Policy Review,
AFMC 02-005 (Atch 3)

1. Technical reports submitted in the attached references listed above are cleared for public release in accordance with AFI 35-101, 26 Jul 01, *Public Affairs Policies and Procedures*, Chapter 15 (Cases AFMC 01-242, AFMC 01-275, & AFMC 02-005).

2. Please direct further questions to Lezora U. Nobles, AFMC CSO/SCOC, DSN 787-8583.

LEZORA U. NOBLES
AFMC STINFO Assistant
Directorate of Communications and Information

Attachments:

1. HQ AFMC/PAX Memo, 26 Nov 01
2. HQ AFMC/PAX Memo, 19 Dec 01
3. HQ AFMC/PAX Memo, 17 Jan 02

cc:
HQ AFMC/HO (Dr. William Elliott)



DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

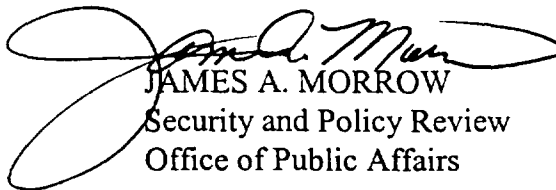
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MEMORANDUM FOR HQ AFMC/HO

FROM: HQ AFMC/PAX

SUBJECT: Security and Policy Review, AFMC 01-275

1. The reports listed in your attached letter were submitted for security and policy review IAW AFI 35-101, Chapter 15. They have been cleared for public release.
2. If you have any questions, please call me at 77828. Thanks.


JAMES A. MORROW
Security and Policy Review
Office of Public Affairs

Attachment:
Your Ltr 18 November 2001

18 December 2001

MEMORANDUM FOR: HQ AFMC/PAX
Attn: Jim Morrow

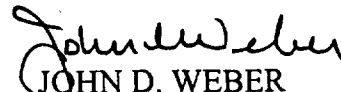
FROM: HQ AFMC/HO

SUBJECT: Releasability Reviews

1. Please conduct public releasability reviews for the following attached Defense Technical Information Center (DTIC) reports:
 - a. *Emergency Fuel Selector Valve Test on the J47-GE-27 Engine as Installed on F-86F Aircraft*, January 1955; DTIC No. AD- 056 013.
 - b. *Phase II Performance and Serviceability Tests of the F-86F Airplane USAF No. 51-13506 with Pre-Turbine Modifications*, June 1954; DTIC No. AD- 037 710.
 - c. *J-47 Jet Engine Compressor Failures*, 7 April 1952; DTIC No. AD- 039 818.
 - d. *Evaluation of Aircraft Armament Installation (F-86F with 206 RK Guns) Project Gun-Val*, February 1955; DTIC No. AD- 056 763.
 - e. *A Study of Serviced-Imposed Maneuvers of Four Jet Fighter Airplanes in Relation to Their Handling Qualities and Calculated Dynamic Characteristics*, 15 August 1955; DTIC No. AD- 068 899.
 - f. *Fuel Booster Pump*, 6 February 1953; DTIC No. AD- 007 226.
 - g. *Flight Investigation of Stability Fix for F-86F Aircraft*, 8 September 1953; DTIC No. AD- 032 259.
 - h. *Investigation of Engine Operational Deficiencies in the F-86F Airplane*, June 1953; DTIC No. AD- 015 749.
 - i. *Operational Suitability Test of the T-160 20mm Gun Installation in F-86F-2 Aircraft*, 29 April 1954; DTIC No. AD- 031 528.
 - j. *Engineering Evaluation of Type T 160 Gun and Installation in F 86 Aircraft*, September 1953; DTIC No. AD- 019 809.

AFMC 01-272

- k. *Airplane and Engine Responses to Abrupt Throttle Steps as Determined from Flight Tests of Eight Jet-Propelled Airplanes*, September 1959; DTIC No. AD-225 780.
- l. *Improved F-86F: Combat Developed*, 28 January 1953; DTIC No. AD- 003 153.
- m. *Flight Test Progress Report No. 19 for Week Ending February 27, 1953 for Model F-86F Airplane NAA Model No. NA-191*, 5 March 1953; DTIC No. AD-006 806.
2. These attachments have been requested by Dr. Kenneth P. Werrell, a private researcher.
3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.


JOHN D. WEBER
Command Historian

13 Attachments:

- a. DTIC No. AD- 056 013
- b. DTIC No. AD- 037 710
- c. DTIC No. AD- 039 818
- d. DTIC No. AD- 056 763
- e. DTIC No. AD- 068 899
- f. DTIC No. AD- 007 226
- g. DTIC No. AD- 032 259
- h. DTIC No. AD- 015 749
- i. DTIC No. AD- 031 528
- j. DTIC No. AD- 019 809
- k. DTIC No. AD- 225 780
- l. DTIC No. AD- 003 153
- m. DTIC No. AD- 006 806